

Citations analysis of publications

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The impact of research can be assessed in various ways. This includes societal impact and, in the case of medical sciences, impact on improving disease outcomes. However, such impact takes time to be recognised. A relatively proximate assessment of the impact of any research can be achieved by analysing citations of it in the published literature.¹ In this editorial, we provide an overview of the assessment of research output by analysing citations (i.e. citation metrics) as well as the pitfalls associated with such an approach.

Citation metrics enable numerical assessment of citations. These metrics can be used at either the journal level or the level of the individual author or article.

Journal-level metrics: These refer to citation practices at journal level (as opposed to those for individual authors or articles). The most widely known journal metric is the journal impact factor (JIF), which is derived from the annually published Journal Citation Reports (JCR). This proprietary metric is currently provided by Clarivate Analytics (formerly by Thomson Reuters) based on citations of a journal's articles in the Web of Science database. The two-year JIF refers to the ratio of the average number of citations that a journal has received in the preceding two years to the number of citable items published in the journal during the same period. Citable items are original research articles (both full-length and brief reports), review articles, case reports, special articles and perspectives, but not editorials, letters to the editor or book reviews. A thematically similar index is the five-year JIF, which considers a similar calculation over the preceding five years. So, a two-year or five-year JIF indicates the average number of citations of articles published in the journal in that specific period.

A higher JIF indicates greater prestige of the journal; however, it does not necessarily reflect the quality of every individual

article in the journal. Review articles are more likely to be cited than original articles, hence journals that publish reviews alone tend to have a higher JIF than those publishing other types of articles. Case reports are of educational interest, but they are less likely to be cited. Hence, journals exclusively publishing case reports or those publishing a large number of case reports in relation to other articles are likely to have a lower JIF.^{2,3}

The Eigenfactor is another journal-level metric that accounts for both the average number of citations and the prestige of the journal in which such citations have occurred. One emerging journal-level metric is the CiteScore, which indicates the average number of citations per journal article in the past three years, based on journals indexed in the Scopus database.²⁻⁴

Journal-level metrics might be unstable. An extreme example of this was observed in the journal *Acta Crystallographica Section A* in 2009, when its JIF rose from 2.0 to 49.9 for a period of two years, then dipped back to its former level of around 2.0. The reason for this was the publication of a methods paper in this journal during the same period, which was widely cited and skewed the average number of citations received by the entire journal.⁵ It is also important to understand that journal-level metrics are prone to manipulation. Recent instances of citation cartels between journals set up to boost their JIF have even resulted in disqualification of journals from the JCR, rendering them ineligible to obtain a JIF. Similarly, self-citations by journals to their own published articles might artificially inflate journal-level metrics. For this reason, the JIF provides metrics excluding and including self-citations. The JCR also penalises journals with excessive self-citation practices by disqualifying them (suppressing their titles) from the JIF in future revisions of the report.^{6,7}

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Journal-level metrics	Author-level metrics	Article-level metrics	Table 1 Citation metrics
Journal impact factor	Number of citations	Number of citations	
CiteScore	h-index	Altmetric Attention Score	
Eigenfactor	i10-index	Plum X Metrics	
	g-index		

Author-level metrics: The simplest author-level metric is the number of citations; however, this does not distinguish self-citations from external citations. The h-index (proposed by Jorge Hirsch) is another commonly used author-level metric. An h-index of 'x' indicates that an author has at least 'x' number of publications, each of which has been cited at least 'x' times. The i10-index indicates the number of publications by an author with at least ten citations. Variations of this include the i20 or i50 (number of publications with 20 or 50 citations respectively). The g-index on the other hand gives more weight to highly cited publications, such that the top 'g' number of publications would have been cited at least 'g²' times in total.^{2,4,8}

Article-level metrics: The number of citations to an article is the simplest example of an article-level metric. With the increasing use of social media, metrics partly reliant on attention to a research article in social media platforms, blogs and newspaper items are increasingly being recognised.⁹ The Altmetric Attention Score indicates these various aspects of a publication in the form of a multicoloured doughnut. The PlumX Metrics are also derived from the Scopus database and indicate five distinct aspects: citations, usage, captures, mentions and social media activity. Usage refers to the number of accesses to an article. Captures indicates bookmarking

on software such as Mendeley. Captured articles might be cited in the future by the person bookmarking them.⁴ Table 1 summarises various citation metrics.

Citations and related metrics differ based on the database from which they are drawn. As alluded to previously, citation-related metrics can potentially be manipulated by increasing self-citations or unnecessary (thereby unethical) citations to and from close collaborators. The number of citations to published work inevitably increases with time, therefore young researchers might have less impressive citation metrics than their senior colleagues. In this context, it is essential to analyse in depth the importance and implications of a particular research work, rather than relying on citation metrics alone. This has been espoused in the San Francisco Declaration on Research Assessment (SF-DORA), which explicitly discourages universities from judging researchers and their work based on analysis of their citation metrics alone.¹⁰

To conclude, citation metrics provide valuable information at the level of the journal, author or individual article. However, they should only be considered as supplementary in the context of the totality of the research output of a particular researcher. It is essential to avoid excessive self-citations unless they are relevant in the context of the manuscript. 

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